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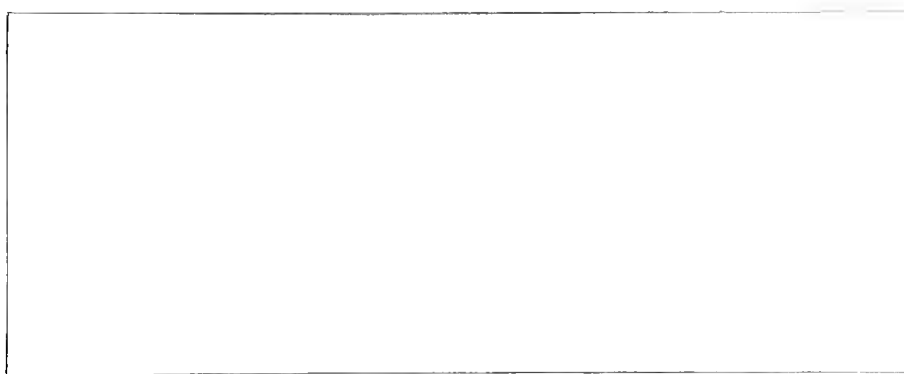department
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EXCESS CAPACITY AS A POLICING DEVICE

Garth Saloner*

M.I.T. Working Paper #360

(Revised November 1984)

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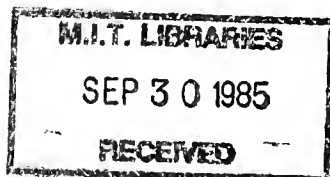
EXCESS CAPACITY AS A POLICING DEVICE

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ABSTRACT

A great deal of recent work has been devoted to the question
of whether an incumbent firm can successfully deter entry by
investing in excess capacity. This paper demonstrates that a
dominant firm may invest in excess capacity even when it is certain
that this will not deter entry. Rather, the excess capacity is
held by the dominant firm in order to ensure that its competitors
will exercise appropriate restraint in their own output decisions.
An example is provided that illustrates that the rate of return on
the capital invested in excess capacity may be very high.

1. INTRODUCTION

There has been considerable debate in the theoretical industrial organization literature on the question of whether a monopolist can successfully deter entry by strategically holding excess capacity (see Spence (1977) and Dixit (1980) for example). The main conclusion of this line of work is that while the monopolist may install more capacity than it would absent the threat of entry, since rational entrants will not be deterred by idle threats, the monopolist will install no more capacity than it will actually use if entry occurs.

This paper uses a model similar in structure to those models to show that a dominant firm may well find it optimal to install excess capacity even though it knows that this will not deter entry. Instead, the excess capacity is put in place to induce the opponent to moderate its output. Thus, the excess capacity serves a policing, rather than a deterring, function.

2. THE MODEL

In order to capture the notion of a dominant firm, we endow one of the firms (say Firm 1) with a first-mover advantage. The timing of the decisions is as follows: Firm 1 chooses its capacity, K_1, then Firm 2 chooses its capacity K_2. Knowing K_1 and K_2, the firms sequentially choose outputs, q_1 and q_2 with $q_i \leqslant K_i$. Thus the structure of the model is similar to that in Kreps and Scheinkman (1983) except that Firm 1 is a Stackelberg leader and the strategic variable is quantity rather than price.

We make no restriction on demand and costs, except that they give rise to well-behaved best-response functions, and that costs are separable into fixed and variable components. For the moment we will assume that fixed costs are zero and later, will comment on some straightforward changes that are necessary to relax this simplifying assumption.

Suppose that Firm 1 has set its capacity at a level sufficient to support its Stackelberg output, q_1^S. Figure 1 illustrates the best-response functions R^1 and R^2 and Firm 1's isoprofit contour corresponding to the Stackelberg outcome, S. Having installed capacity q_1^S, Firm 1's best-response function becomes ACq_S^1. Suppose now that Firm 2 installs capacity of K_a^2. In selecting its output, Firm 1 selects its most preferred point along Firm 2's capacity-constrained best-response function K_a^2BM, or point a. Firm 2 then selects its best-response which is of course K_a^2.

– Figure 1 –

Now suppose instead that Firm 2 had selected a capacity level of K_b^2. Firm 1's optimal output would then have been q_1^S, giving rise to the Stackelberg outcome. More generally, the locus of equilibria that are mapped out as Firm 2 changes its capacity level from zero to K^* is $q_1^S CD$. As Firm 2 increases its capacity beyond K^*, however, the locus of equilibria jumps discontinuously to S. This discontinuity follows from the fact that Firm 1 prefers its Stackelberg outcome to any outcome where Firm 2 produces more than K^*.

Consider Firm 2's preferences represented by the dotted isoprofit contours. Clearly Firm 2's most preferred point on the locus of equilibria is point D.
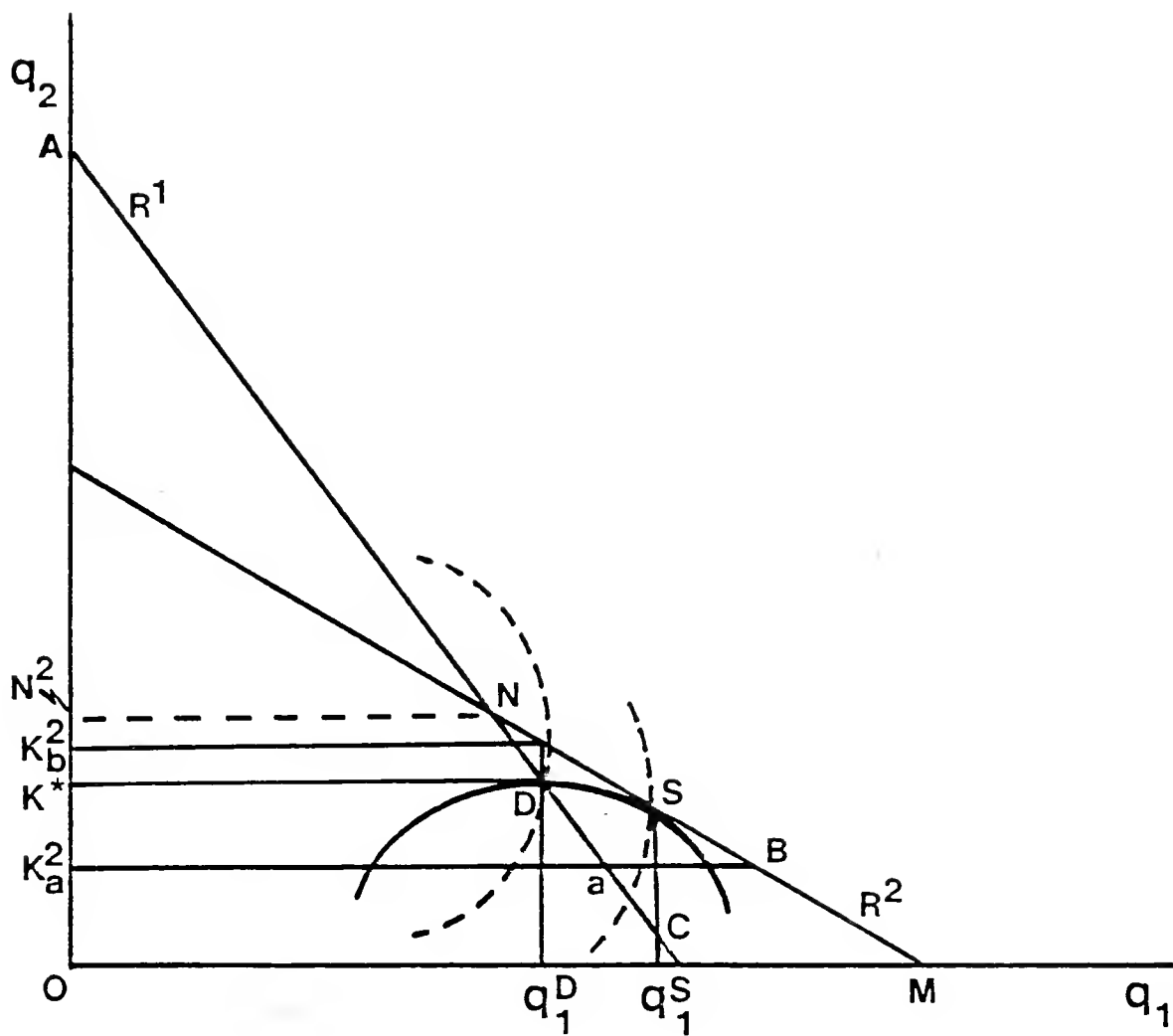
FIGURE 1

Thus if Firm 1 selects capacity $K_1 = q_1^S$ the optimal actions thereafter are $K_2 = K^*$, $q_1 = q_1^D$ and $q_2 = K^*$. (More precisely, since Firm 1 is indifferent between outcomes S and D, Firm 2 will break this indifference by setting $K_2 = K^* - \varepsilon$ for ε arbitrarily small).

The interpretation of this outcome is the following: A farsighted Firm 2 realizes that if it installs "too much" capacity (i.e. in excess of K^*) the dominant firm will exert its dominance by ensuring the Stackelberg outcome. However if Firm 2 can commit to restraining itself, the dominant firm will be induced to settle on an outcome more favorable to Firm 2. Firm 2 is rewarded with higher profits for its promise to remain small. The capacity level K^* serves as an imaginary line drawn by the dominant firm which if "stepped over" will elicit a tough response.

There are two key features to note about this outcome. Firstly, the follower is able to improve its outcome by restraining itself. This is analogous to the result obtained by Krishna (1983) in a differentiated products model. More importantly, however, is the fact that Firm 1 produces only q_1^D whereas it has the capacity to produce q_1^S! Why then would a farsighted Firm 1 install so much capacity at the outset? Suppose instead that Firm 1 installed capacity $K_1 = q_1^D$. The locus of equilibria that would be mapped out as Firm 2 varied K_2 from zero to N^2 would then be $q_1^D DF$ (Figure 2) followed by a discontinuous jump to E . Using the same argument as before the resulting outcome would be point F which lies on a less favorable isoprofit contour for Firm 1 than point D. If the restraint placed on Firm 2 by Firm 1's ability to produce its Stackelberg outcome

is lacking, Firm 2 will take advantage by installing additional capacity and expanding its output.

- FIGURE 2 -

The effect of fixed costs is now easily seen. Provided the difference in revenues for Firm 1 between outcomes D and F exceeds the difference in fixed costs between holding capacity at the Stackelberg outcome and the outcome corresponding to point F, the unique equilibrium configuration will have $K_1^* = q_1^S$, $K_2^* = K^*$, $q_1^* = q_1^D$ and $q_2^* = K^*$. At this equilibrium the dominant firm holds excess capacity but the follower does not.

3. AN EXAMPLE

Schmalensee (1981) has shown that in a model with linear or concave demand the monopoly stream that can be shielded from entry by investment in excess capacity is less than the capital cost of a firm of minimum efficient scale. This suggests the general unimportance of excess capacity as an entry deterring device. This section presents an example that illustrates the results of the previous section and demonstrates that the rate of return on the excess capacity in this model may in fact be quite substantial.

Consider an industry with a linear inverse demand curve given by $P = a-Q$ where $Q = q_1 + q_2$. Let the firms have equal constant marginal costs of production, c, and define $k \equiv a-c$. It is well known that for this model the Stackelberg outcome has $q_1^S = k/2$ and $q_2^S = k/4$ ($Q^S \equiv q_1^S + q_2^S = 3k/4$), the Cournot outcome has
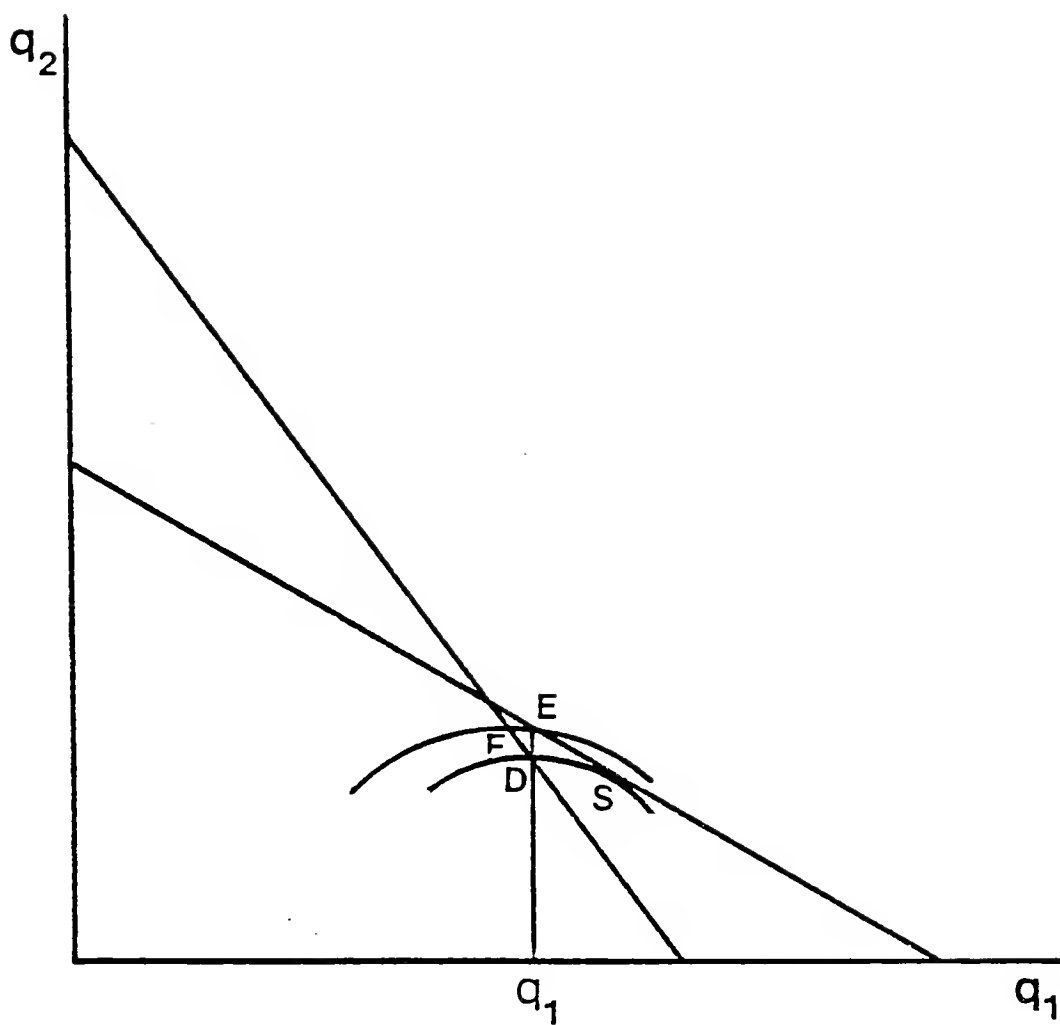
FIGURE 2

$q_1^C = qk/3 = q_2^C$ $(Q^C \equiv q_1^C + q_2^C = 2k/3)$ and the collusive outcome has $Q^m = k/2$. Thus $Q^m < Q^C < Q^S$.

We now calculate the equilibrium outputs in the model of the previous section. Point D in Figure 1 occurs where Firm 1's isoprofit contour corresponding to its Stackelberg outcome and the profits on its best-response function coincide. At the Stackelberg point Firm 1 earns

$$\Pi_1^S = (k - q_1^S - q_2^S) q_1^S$$
$$= k^2/8. \quad (*)$$

Its best-response function is given by $q_1 = (k - q_2)/2$. Thus its profits along its best-response function, say $\Pi_1^R(q_1, q_2)$, are given by $\Pi_1^R = (k - q_1 - q_2) q_1$ where $q_2 = k - 2q_1$. Substituting for q_2 and rearranging yields

$$\Pi_1^R = q_1^2. \quad (**)$$

Equating (*) and (**), point D is defined by $q_1^2 = k^2/8$ or $q_1^D = k/\sqrt{8}$ (with revenues for Firm 1 of $0.125\ k^2$) and $q_2^D = k - 2k/\sqrt{8}$. Thus total output at point D is given by $Q^D = q_1^D + q_2^D = 0.642k$. Notice that $Q^m < Q^D < Q^C < Q^S$ so that the sum of consumer and producer surplus is not only lower than at the Stackelberg outcome, but is even lower than at the Cournot outcome.

Using the fact that $q_1^D = K/\sqrt{8}$ we can calculate the co-ordinates of point F in Figure 2 in exactly the same way as above. This yields

$$q_1^F = k \left[\frac{1}{2\sqrt{8}} - \frac{1}{16} \right]^{1/2} \approx 0.338K, \quad q_2^F = (k - q_1^F)/2 = 0.331k \quad \text{and revenues}$$

to Firm 1 of $0.112k^2$. The excess of Firm 1's revenues from point D over point F are therefore $0.013k^2$. The excess capacity at point D is given by

$q_1^S - q_1^D = k/2 - k/\sqrt{8} = 0.146k$. If the average cost per unit of additional capacity when capacity is increased from q_1^D to q_1^S is r, the rate of return on the excess capacity is $0.013k^2/0.146rk = 0.089k/r$. Recalling that $k = a-c$ which is quite independent of r, it is clear that there is no natural bound on the rate of return that can be earned on excess capacity. (In the limit (if r is zero) the excess capacity is costless and yet ensures increased revenues of $0.013k^2$).

4. CONCLUSION

This paper has presented a model in which a dominant firm holds capacity in excess of its needs in order to exert some discipline over the follower. The optimal response of the follower, in turn, is to restrain its output choice so as to encourage the dominant firm to produce a relatively low output. The welfare losses in this equilibrium are twofold: output is reduced from Stackelberg levels to below the Cournot level and costly excess capacity is held by the dominant firm.

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